

## WATER, ENVIRONMENT AND HEALTH: IMPLICATIONS ON CASSAVA PRODUCTION.

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### ABSTRACT

The paper examines the implications of water, environment and health on cassava production. It was observed that although, cassava is a drought- tolerant crop, growth and yield are decreased by prolonged dry periods. The critical period of water deficit effect in cassava is from 1-5 Month After Planting (the stages of root initiation and tuberization). Also, cassava processing can have negative, mainly site-specific effects on the environment, by producing unpleasant odours and an unsightly display of waste. Consumption of cassava and cassava products containing large amounts of cyanide can cause acute intoxication, with symptoms of dizziness, headache, nausea, vomiting, stomach pains, diarrhoea and sometimes death. Policies and institutions must be developed and cost-effective management practices adopted to halt the environmental degradation caused by overexploitation of groundwater resources. Processors or intending cassava processors should make adequate arrangement for proper disposal of effluents and other waste from cassava. Cyanide poisoning can be prevented through educating farmers and consumers of cassava and cassava products on the need to extend fermentation period of cassava.

**KEYWORDS:** water, environment, health, cyanide poisoning, death, drought tolerant, fermentation

### INTRODUCTION

Agriculture produces the necessary food for the world's populations under both rainfed and irrigated conditions. In a wider perspective, agriculture is not only the main consumer of water but also a critical factor shaping important terrestrial and freshwater biomes that form part of necessary life-supporting eco- system services (Appelgren and Klohn, 2001). Agriculture represents the first traditional life-supporting economic sector closely linked to established cultural and ethical values of land and water on which traditional societies are built (Appelgren, 2004).

Agriculture is the activity most essential for human survival. It feeds people, produces basic commodities for society and provides gainful employment for the majority (Ojemade, 2007). Agricultural demands represent actual current use of rainfall, soil moisture and flowing waters for agricultural production. This is different from generally planned demands and an enormous, rapidly growing investment gap for water supplies, sometimes referred to as the *water supply paradox* (Appelgren, 2004).

Based on the standard hydrological index of water scarcity it is concluded that by 2025 one-third of the world's population will live in water scarce countries. The water scarce countries include many of the least developed countries with limited social resources but also more wealthy economies with the necessary capacity for investments and social adaptation to water scarcity (Appelgren, 2004).

Agriculture is the largest user of water in the world and alters, depletes, contaminates, and eutrophies water bodies—all of which have implications for human health. Water-associated infectious disease kill approximately 3.2 million people per year and a significant fraction can be traced back to agriculture-imposed changes in vector habitat and water quality (Nugent and Drescher, 2006).

Cassava (*Manihot esculenta* Crantz) has its origin in Latin America where it has been grown by the indigenous Indian population for at least 4000 years. After the discovery by the Americas, European traders took the crop to Africa as a potentially useful food crop; later it was also taken to Asia to be grown as a food security crop and for the extraction of starch. It is native to tropical America and was introduced to Africa by the Portuguese in the sixteen century (Okogbenin *et al.*, 2006).

According to Howeler, 2006 cassava belongs to the family Euphorbiaceae. It can compete with other, more valuable, crops such as maize, soybean and vegetables mainly in areas of acid and low-fertility soils, and those with low or unpredictable rainfall. It is a major source of carbohydrate and it is the third largest source of carbohydrate in the world with Africa being the largest centre of production.

Nigeria is the largest producer of cassava in the world (FAO,2007) and its cassava transformation is the most advanced in Africa (Egesi *et al.*, 2006).Cassava is grown throughout the tropic and could be regarded as the most important root crop, in terms of area cultivated and total production (Ano,2003).It is a major food crop in Nigeria (Ogbe *et al.*, 2007).It is strategically valued for its role in food security, poverty alleviation and as a source of raw materials for agro-allied industries in Nigeria with huge potential for the export market (Egesi *et al.*, 2007).

Cassava can be a powerful poverty fighter in Africa. The cash income from cassava proves more egalitarian than the other major staples because of cassava's low cash input cost (Nweke, 2004). According to Egesi *et al.*, 2006 cassava has in recent years transformed from famine reserve commodity and rural staple to a cash crop in Africa

Cassava (*Manihot esculenta* Crantz) is a very important crop in Nigeria deriving from the extensive use of the various products and by-products as staples to most Nigerians. The consumption of cassava cuts across all parts of the country. Its adaptability to climatic and soil conditions even in marginal soils has endeared cassava to most people that have to do continuous cultivation on limited available land. The general acceptance of cassava and its products to all classes of Nigerians on its own draws close attention to the producers of cassava (Olanrewaju *et al.*, 2009).

Fuglie, 2002 reported that cassava is a competitive crop, especially for the production of starch and animal feed. The use of cassava from 1993-2020 is predicted to increase by around 1.74 per cent per annum in the region. This implies that there is room to expand production. Moreover, improvements in quality, processing, and product marketing could increase the value of cassava products by about 20 per cent (Harshey *et al.*, 2000).

It is a known fact that plants require some resources to produce optimally and lack and or excess of these would in no small measures have implications on their productivity. The broad objective of this paper was to examine the implications of water, environment and health on cassava production.

#### Water and Cassava production

The importance of water in cassava production cannot be over emphasized. Water is needed in cassava production though not in quantities that will cause rot to the tubers. Cassava is a drought resistant crop that does well where other crops fail. Water is one of the most important inputs essential for the production of crops. Plants, including cassava need it continuously and in appropriate quantities during their life.

According to Olanrewaju *et al.*, 2009 water is the most important compound in an active plant and constitutes more than 80% of the growing tissue. Because it is essential for most plant functions, the amount of water applied during irrigation, the time and method of water application, the quality of the irrigation water, and prevailing micro-meteorological conditions are important in plant health and yield.

The inability of a plant root system to supply such demands is one of the principal constraints of plant productivity (Baker *et al.*, 1992).Water is essential for agricultural production and its linkage to food security and population issues are often reflected in water scarcity and per capita water availability with finite water resources distributed over growing populations (Appelgren, 2004).

Plants require water for photosynthesis, growth, and reproduction. Water used by plants is non-recoverable, because some water becomes a part of the plant chemically and remainder is released into the atmosphere. The processes of carbon dioxide fixation and temperature control require plants to transpire enormous amounts of water. Various crops transpire water at rates between 600 to 2000 litres of water per kilogram of dry matter of crops produced (Pimentel *et al.*, 2004).

According to Bray 1994, plants respond to water deficit at many different levels: morphologically, physiologically, cellular and metabolically. The responses are dependent upon the duration and severity of stress, the genotype of the stressed plant, the stage of development and the organ and cell type in question.

Water influences photosynthesis, respiration, absorption, translocation and utilization of mineral nutrients, and cell division besides some other processes. Both its shortage and excess affects the growth and development of a plant directly and consequently, its yield and quality. Rainfall is the cheapest source of natural water-supply for cassava and other plants (Dhanapal and Eswaramoorthi, 2005).

When water is available, cassava maintains a high stomatal conductance and can keep internal carbon dioxide (CO<sub>2</sub>) concentration high; but when water becomes limiting, the plant closes stomatal in response to even small decreases in soil water potential (El-Sharkawy and Cork 1984).

Porto *et al.*, 1988 submitted that leaf conductance to water vapour has been evaluated as an indicator of the capacity of different cassava genotypes to prevent water loss under prolonged drought. Considerable variation has been observed in leaf conductance and this parameter seems to be useful for pre – selecting sources of germplasm conferring adaptation to prolonged dry periods.

The growing scarcity and competition for water, however, stands as a major threat to future advances in poverty alleviation. In an environment of growing scarcity and competition for water a comprehensive strategy is needed to improve the productivity of water in both irrigated and rain-fed agriculture and to ensure access to water by poor men and women (Barker *et al.*, 1992).

Alves 2002 reported that cassava is commonly grown in areas receiving < 800mm rainfall per year with a dry season of 4-6 months, where tolerance of water deficit is an attribute. The critical period of water deficit effect in cassava is from 1-5 MAP (the stages of root initiation and tuberization).

Water deficit during at least 2 months of this period can reduce storage in root yield from 32-60%. Although, cassava is a drought- tolerant crop, growth and yield are decreased by prolonged dry periods. The reduction in storage root yield depends on the duration of the water deficit and is determined by the sensitivity of a particular growth stage of water stress (Connor *et al.*, 1981; Porto *et al.*, 1988).

#### Environment and cassava production

Agricultural production, according to Nugent and Drescher 2006 relies on environmental services to transform raw inputs into the nutritious and diverse food that humans rely on for survival. Modified agricultural practices can help mitigate these problems. The continuous increase in the supply and demand of cassava in developing countries has accentuated the negative impact cassava production and processing has had on the environment and biodiversity (FAO, 2001).

Ekundayo, 1997 reported that activities on the environment tend to hinge on effluents which may include acids, oils and cooling water. All these consequently create a cascading concern about the protection and safety of the environment. Subair, 2009 reported that where there is no serious concern for the environment or measures for containing its problems, several issues such as indiscriminate dumping of waste, illegal mining and pollution are often inescapable.

The continued loss of forests and other vegetation plus the accumulation of carbon dioxide, methane gas, and nitrous oxides in the atmosphere during land cultivation for cassava production can lead to global climate change. Over time, such changes may alter present precipitation and temperature patterns throughout the world (Downing and Parry, 1994).

Cassava is found over a wide range of edaphic and climatic conditions between 30°N and 30°S latitude, growing in regions from sea level to 2300m altitude, mostly in areas considered marginal for other crops: low-fertility soils, annual rainfall from < 600mm in the semiarid tropics to >1500mm in the subhumid and humid tropics (Alves,2002).

Irikura *et al.*, 1979, identified temperatures, photoperiods and solar radiation as environmental factors that have effects on cassava production. At a temperature of 15-24°C, the leaves remain on the plant for up to 200 days while at a higher temperatures leaf life is 120 days (Splittstosser and Tunya, 1992). This invariably may reduce photosynthetic activities of cassava which is eventually transmitted to low and poor yield of the crop.

Furthermore, cassava is a crop that requires high solar radiation to perform photosynthesis more efficiently (El-Sharkawy *et al.*, 1992), it is therefore very important to know the effect of shade on cassava development and production. Okoli and Wilson (1986) found out that shade delayed storage root bulking on cassava subjected to six shade regimes of 20, 40, 50, 60 and 70%. Cassava yield obtained were reduced by 43, 56, 59, 69, and 80% respectively. This finding shows that shade has a negative influence on yield and productivity of cassava. Subsequently, under limited photosynthesis caused by low solar radiation, most of the photosynthates are utilized for shoots growth, affecting storage root development significantly, showing that the shoots are a stronger sink than roots (Alves, 2002).

The recent Nigerian government's encouragement to grow and process more cassava for domestic and international needs resulted in corresponding increase in production and processing thus increased amount of cassava effluent discharged on the environment (Ehiagbonare *et al.*, 2009). A poisonous substance called cyanide occurs in various concentrations during cassava processing depending on the varieties. Forty to seventy percent of the total cyanide appear in the water used to wash the disintegrated cassava and 5 to 10% in fibrous residue used in animal feed.

Ehiagbonare *et al.*, (2009) reported that waste water from cassava processing is released into the environment without proper treatment in most rural areas where cassava is processed. This has been identified as a source of pollution. Waste water running freely along surfaces contaminates agricultural surface water, stream, as it percolates into the underground water, and the subsoil, domestic animals, man, fauna and flora; it may have effect on plants as vegetation is hardly noticed on such areas (Ogundola and Laiasu, 2007).

Arotupin, 2007 submitted that during the processing of cassava tubers into various products, liquid waste waters generated was reported to cause serious havoc to vegetations, houses and bring about infection. This no doubt have being causing serious environmental pollution as a result of the indiscriminate discharge.

#### Health and cassava production.

Good health and productive agriculture are important in the economy of any nation especially in the fight against poverty. Health enhances work effectiveness and the productivity of an individual through increase in physical and mental capacities (Ajani and Ugwu, 2008). Although the practice of agriculture is essential for human health, careless and inappropriate agricultural practices can degrade and contaminate natural resources and in so doing, harm human health (Nugent and Drescher 2006).

All cassava organs, except seeds, contain Cyanogenic Glucosides (CG). Cultivars with < 100 mg kg<sup>-1</sup> fresh weight (FW) are called 'sweet' while cultivars with 100-500 mg kg<sup>-1</sup> are 'bitter' cassava (Wheatley *et al.*, 1993). Total Cyanogenic Glucosides concentration depends on cultivar, environmental condition, cultural practices and plant age (McMahon *et al.*, 1995).

Naturally occurring acyanogenic cassava has never been observed (Bradbury and Holloway, 1988). Since linamarin is bitter (King and Bradbury, 1995), high-cyanide cassava roots containing >100ppm cyanide are normally bitter and are called bitter cassava. One such variety in Nigeria is called 'chop and die'.

It is difficult to understand how cassava can be promoted without giving proper consideration to the fact that it contains a cyanogen (linamarin) that liberates poisonous cyanide in the body (Madamombe, 2006). When linamarin is hydrolysed, it releases hydro cyanide, a volatile poison (Cooke and Coursey, 1981); but some cyanide can be detoxified by the human body (Oke, 1983).

In some varieties of cassava the interior of the roots (parenchyma) contains only a small amount of cyanide. This is called sweet cassava, which may be boiled and eaten, as is normal in the South Pacific (Bradbury and Holloway,

1988). However, Cardoso *et al.*, 2005 reported that in Amazonia (the original source of cassava) and in Africa different varieties have a range of total cyanide contents in the parenchyma from very low to very high (1–1550 ppm).

Cardoso *et al.*, 2005 and Siritunga *et al.* 2004 in separate studies reported that linamarin is present in large amounts in the leaves and the peel of cassava roots (900–2000mg HCN kg<sup>-1</sup> fresh weight) and the leaves also contain a second enzyme called hydroxynitrile lyase, which catalyses the hydrolysis of acetone cyanohydrin to produce HCN and acetone.

Cyanogenesis is initiated in cassava when the plant tissue is damaged. Rupture of the vacuole releases linamarin, which is hydrolyzed by linamarase, a cell wall-associated  $\alpha$ -glycosidase (McMahon *et al.*, 1995). The linamarin content of cassava flour was reported to be more than double during drought (Cardoso *et al.*, 2005; Ernesto *et al.*, 2002), which leads to outbreaks of konzo; most recently there were more than 100 cases in Nampula and Zambezia Provinces due to drought in 2005 (Muquingue *et al.*, 2005).

Cassava is increasingly popular with farmers particularly in countries of tropical Africa simply because of its agricultural advantages and potential to feed rapidly increasing populations. Also households under stress from HIV/AIDS are switching from high-input to low-input farming systems that involve cassava (FAO, 2008).

Consumption of cassava and cassava products containing large amounts of cyanide can cause acute intoxication, with symptoms of dizziness, headache, nausea, vomiting, stomach pains, diarrhoea and sometimes death (Mlingi *et al.*, 1992). Since the lethal dose of cyanide is proportional to body weight, children tend to be more susceptible to outright poisoning than adults. In regions where there is iodine deficiency, which causes goitre and cretinism, cyanide intake from cassava exacerbates these conditions (Delange *et al.*, 1994).

Ihedioha and Chineme 2003 in their work suggested that shortening the fermentation period of cassava mash to about 24 hours constitutes a health hazard to consumers of gari. Various health disorders are associated with the consumption of cassava, which contains residual cyanogens. These disorders include hyperthyroidism, tropical ataxic neuropathy, and konzo (Osuntokun, 1981).

When cassava is eaten, most of the ingested cyanide is converted into thiocyanate, a reaction catalysed by the enzyme Rhodanese, which uses up part of the pool of S-containing essential amino acids methionine and cysteine/cystine (Osuntokun, 1981; Westly, 1988; Cardoso *et al.*, 2004). These amino acids are essential in the diet because they can only be obtained from the food consumed.

A shortfall of these S-containing amino acids would limit protein synthesis and could cause stunting of growing children, as was found in a study of children in DRC (Cardoso *et al.*, 2004).

A study made in Nampula Province in Mozambique showed that an estimated maximum cassava flour intake of children in an area prone to konzo was 700–900 g fresh flour per child per day and in a non-konzo area was 20–140 g fresh flour per child per day (Cardoso *et al.*, 2004).

It is important that the introduction of cassava into new regions is accompanied by efforts to educate the people in correct methods of processing of cassava to remove cyanogens, rather than simply ignoring the dangerous aspects of this crop (Madamombe, 2006).

It is likely that the high rate of population increase in these tropical African countries is a major cause of increased cassava production, which highlights the need for proper health safeguards against cyanide diseases.

#### RECOMMENDATION

Policies and institutions must be developed and cost-effective management practices adopted to halt the environmental degradation caused by overexploitation of groundwater resources. Special attention must be given to implementing policies and developing technologies suitable for adoption by resource- poor farmers in water-scarce

or marginal upland and rain-fed areas, particularly those in sub-Saharan Africa. Measures should be taken to control or minimise disease conditions that are related to cyanide poisoning, konzo and TAN intake in the diet of people who consume cassava and cassava products. As young tissues (meristems) are involved in regrowth and recovery after drought, further research is needed to give a fuller picture of cassava's response to water deficit.

## CONCLUSION

To implement sustainable solutions, more specific knowledge of the linkages between agriculture, environment and health is needed, particularly on the human health effects of specific agricultural activities and the cumulative and interactive impacts of multiple environmental changes. And while acute health impacts are relatively identifiable, better knowledge of the chronic health problems that arise from unhealthy agricultural practices is required.

In the meantime, action is needed at the policy level. Policies aimed at environmental protection or resource conservation already exist in many countries. These policies should be enforced and also examined and possibly retooled to ensure that they are maximizing human health benefits.

Although any positive health outcomes would be revealed only over the long term, such approaches are needed as human health becomes a higher priority in agricultural decision making. After all, agriculture relies on the productivity of the environment for its survival, and humans rely on agricultural productivity for their survival.

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